

THE FUTURE OF CALIFORNIA CAP-AND-TRADE:
QUESTIONS AND SCENARIOS

by
Andrew Matthews

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Project Approved:

Steven Mann, Ph.D.
Department of Finance
(Supervising Professor)

Peter Locke, Ph.D.
Department of Finance

Ira Silver, Ph.D.
Department of Finance

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INTRODUCTION

The purpose of this paper is to provide an overview of future scenarios and events in California that could affect the evolution of the California cap-and-trade market. Cap-and-trade is a market-based mechanism enacted by governments to decrease emissions in their respective jurisdictions. The theoretical basis of a cap-and-trade program is to place a price on greenhouse gas emissions to incentivize corporations to make capital investments in their business to decrease their respective emissions. Industries are assigned an emissions cap, or an emission threshold, that decreases over time. Emissions that exceed this threshold must be paid for through the purchase of emissions credits. At some point in time, the cost of investing in emissions abatement technology is expected to be less than the cost of purchasing the required emissions credits that exceed their cap. Thus, the economy encompassed by the program is gradually transformed into one that emits less than it would under a business as usual scenario. Many governments view cap-and-trade as a more effective emissions reduction strategy than other options, such as carbon taxes.

Outside of the United States, there are currently cap-and-trade programs in the European Union, the Netherlands, and China. Other countries such as South Korea will begin cap-and-trade programs in the near future. The first United States cap-and-trade program began in 2003 with the Regional Greenhouse Gas Initiative (RGGI). This program only applies to energy providers, but boasts tremendous success in emissions reductions since its inception. Later in 2003, the Chicago Climate Exchange began, which was a voluntary program that ultimately shut down in 2010 when the prospects of a national cap-and-trade program terminated with the failure of the Waxman-Markey Bill

in the United States Congress. The establishment of these markets, combined with the increased global awareness of, and actions towards combatting climate change creates a strong case that carbon markets will be prevalent throughout the 21st century. In the words of the International Panel on Climate Change (IPCC) Chairman Rajendra Pauchari, “The financial markets are humanity’s only hope in the battle against climate change” (Bawden, 2013, p.2).

The California cap-and-trade program is an essential component of the state’s Global Warming Solutions Act, otherwise known as AB32, passed in 2006. The goal of this legislation is to reduce the state’s emissions to 1990 levels by 2020. The California program is important for many reasons, and has global and domestic implications. California is the ninth-largest economy in the world, making its cap-and-trade program the second largest in the world, second only to the European Union Emissions Trading Scheme (EU ETS). It is the first regulated multi-sector cap-and-trade market in the United States that encompasses not only electricity and energy providers, but also industry. The program can serve as a model for other states to replicate in the future, or as an established market to join. The Canadian Province, Quebec, is set to link with the California program in January 2014. A nationwide cap-and-trade scheme is unlikely in the near future, but California’s program could serve as a model for this type of scheme as well. The aforementioned cap-and-trade developments will only occur if the California market is successful. Thus, a lot is at stake as the market evolves going forward.

The California cap-and-trade program is still in its nascent stages, as the first auction commenced in November, 2012, and compliance obligations kicked in January 1, 2013. The program is currently in its first compliance period, with the second and third

compliance periods set to begin in 2015 and 2018. The program is scheduled to end in 2020, but this is unlikely with most market participants predicting an expansion of the program to at least 2030. The future of the market is far from certain, however, and could move in different directions going forward.

There is a general consensus among market participants and analysts, though, that the market will remain largely oversupplied through 2020. That is, there will be more than enough allowances and offsets in the market to meet the demand for these compliance instruments. Emissions are not forecasted to rise significantly, and allowance prices should sit just above the floor price for the remainder of the decade. Offset supply is expected to increase throughout the decade, further adding to the supply demand imbalance. The linkage with Quebec in 2014 is expected to only add moderate increases to allowance prices as well. The only notable bullish market behavior expected to occur is in Q4 2014, when fuel suppliers could begin hedging their 2015 exposure, when they are brought into the market; and secondly, in 2019 when there will be a high degree of speculation about the post-2020 cap, and possible allowance shortages. So fundamentally, allowance prices should remain in a bearish state for the remainder of the decade, a sentiment echoed by all the market participants interviewed in this analysis.

The focus of this study is the potential scenarios and events that could derail the program from the path that the majority of analysts believe the market will take. The analysis presents two possible scenarios that have the greatest potential to increase emissions, and thus the demand for compliance instruments. Allowance and offsets prices would rise significantly, and trading volumes would surge. Both scenarios currently are not considered likely to come to fruition; but as this analysis reveals, there is evidence

that they are realistic possibilities. The first event is the shutdown of the Diablo Canyon nuclear power plant, the only remaining source of nuclear energy in the state. The facility is owned by Pacific Gas & Electric (PG&E), provides the company with 23% of its electricity generation, and satisfies roughly 10 percent of California's electricity needs. Following the recent shut down of the San Onofre Nuclear Generating Station (SONGS), Diablo Canyon is the largest source of clean energy in the state. This study explores the situations that could lead to its shutdown, and how the shutdown would affect the cap-and-trade market.

The second bullish scenario concerns the possibility of a shale oil boom from the largest crude oil reserve in the United States, the Monterey/Santos Shale in Southern California. The Monterey is the source rock for most of the oil fields in California, but could be exploited as a reservoir rock in the future. The U.S. Energy Information Association (EIA) estimates around 15.4 billion barrels of technically recoverable oil in the shale. There currently has been no real production breakthrough in the shale, but the application of new extraction techniques could lead to a breakthrough. These new extraction techniques, such as hydraulic fracturing and deep acid injection, are under new regulations and scrutiny in the state. This study analyzes the legislative aspects in California, like the recently passed "fracing bill" SB4, that could help or hinder oil companies in their quest for oil. Lastly, the analysis examines the potential effects a shale oil boom would reap on the cap-and-trade market.

The goal of this report is to analyze the effects of potential market disruptions that would derail the cap-and-trade program from its current forecasted path. The paper will begin by describing how California's cap-and-trade program works, describing its current

regulations and how different components affect each other. Then, it will provide a history of the market to date, and how the market is expected to evolve. This portion of the analysis will utilize resources from Bloomberg New Energy Finance (BNEF), whose projections are well-respected according to market participants. The analysis will evaluate potential market altering variables, paying special attention to the significant bullish scenarios: the shutdown of the Diablo Canyon nuclear power plant and an oil boom stemming from the Monterey/Santos shale. Lastly, a conclusion will present an overview of the findings in this analysis, and describe the questions in the market that remain in the future.

METHODOLOGY

The data collection techniques used for this analysis are based on archival resources and personal interviews. The study utilized numerous scholarly reports, data, and articles from reputable sources. The most notable resources stem from the California Air Resource Board (ARB), the U.S. Energy Information Administration (EIA), and Bloomberg New Energy Finance (BNEF). Personal interviews were conducted with employees of companies directly involved with the cap-and-trade program. The interviews were unstructured, and the views and opinions expressed in this analysis do not necessarily reflect their personal opinions, nor do they reflect the opinions of their respective companies. The list of interviewees is outlined on the next page.

Name	Company	Role
Alex Rudee	Southern California Edison (SCE)	Emissions Trader
William Nelson	Bloomberg New Energy Finance (BNEF)	North American Carbon Analyst
Colleen Regan	Bloomberg New Energy Finance (BNEF)	North American Carbon Analyst
Morgan Hagerty	CE2 Carbon Capital	Director
Belinda Morris	American Carbon Registry (ACR)	Director
David Diaz	EcoTrust	Forestry Program Manager
Bob German	DTE Energy Trading, Inc.	Senior Carbon Emissions Trader
Ana Garza-Beautz	Sempra Utilities	Compliance Officer
Ashley Lawson	Thomson Reuters Point Carbon	Carbon Analyst
Sheldon Zakreski	The Climate Trust	Director of Programs

The conversations with the market participants listed above were critical to understanding the California cap-and-trade market.

THE CALIFORNIA CAP-AND-TRADE MARKET

Summary

The California cap-and-trade program is part of California's AB32 scoping plan, which stems from the California Global Warming Solutions Act of 2006. The Act imposes a reduction in emissions to 1990 levels by 2020, equating to a 25% reduction in statewide emissions, and ultimately an 80% emissions reduction by 2050. The California Air Resources Board (ARB) is the governing body in charge of the administration of cap-and-trade. ARB adopted the cap-and-trade regulation on October 20, 2011; the regulation took effect January 1, 2012; the first auction took place on November 14, 2012; and compliance obligations began on January 1, 2013. The six greenhouse gases covered in the program include: Carbon Dioxide (CO₂), Methane (CH₄), Nitrous Oxide (NO₂),

hydro fluorocarbons (HFCs), chlorofluorocarbons (CFCs) and Sulfur hexafluoride (SF6). Emissions are measured in 1 ton of Carbon Dioxide or Carbon Dioxide equivalent (CO₂e). Companies that emit more than 25,000 tons of CO₂e are covered entities under the program. ARB's goal and basic outline of cap-and-trade is described below:

Cap-and-trade is a market based regulation that is designed to reduce greenhouse gases (GHGs) from multiple sources. Cap-and-trade sets a firm limit or "cap" on GHGs and minimize the compliance costs of achieving AB 32 goals. The cap will decline approximately 3 percent each year beginning in 2013. Trading creates incentives to reduce GHGs below allowable levels through investments in clean technologies. With a carbon market, a price on carbon is established for GHGs. Market forces spur technological innovation and investments in clean energy. Cap-and-trade is an environmentally effective and economically efficient response to climate change (ARB, 2011).

ARB's basic responsibilities are to establish the regulations and amendments to the program, facilitate the quarterly auctions of California Carbon Allowances (CCAs), and issue offset credits. Auctions are held quarterly, with two auctions held each quarter, an Auction of allowances from the Current and Previous Budget Years and the Auction of Allowances from Future Budget Years. The auction bidding format includes a single round of sealed bidding, with bid quantities being multiples of 1,000 California GHG allowances. Auctions include a price floor known as an auction reserve price, which was \$10 in the November 2012 auction, \$10.71 in 2013 auctions, and increases 5% each year plus the annual inflation rate. There is an auction purchase limit that sets the maximum

number of allowances an entity or group of entities can purchase. Each bidder may submit multiple bids with bids considered in declining order by price.

The current cap-and-trade regulation has three compliance periods between 2013 and 2020, in which companies covered under the program must comply with the “cap”, or limit on emissions, that ARB designates. The allowance budget for the program is outlined in Appendix A. The first compliance period began on January 1, 2013, and requires electric utilities and large industrial facilities that emitted more than 25,000 metric tons of carbon dioxide equivalent during any year between 2008 and 2011 to decrease their emissions by 2 percentage points below the 2012 emissions level forecast during 2013, and another 2 percent in 2014.

The second compliance phase begins on January 1, 2015 for companies that emitted 25,000 metric tons of carbon dioxide equivalent in any year from 2011-2014 . In 2015, distributors of transportation, natural gas and other fuels are added to the program to the program, bringing the total number of businesses covered to around 350, representing roughly 600 facilities and 85% of California’s total greenhouse gas emissions. The third compliance period begins on January 1, 2018. The emissions cap from 2015 to 2020 is set at about 3 percent annually. The annual compliance obligation for a covered entity equals 30 percent of GHG emissions from the previous year. (ARB Article 5, 2013, p. 98) Compliances instruments must be surrendered:

By November 1 of the calendar year following the year for which the obligation is calculated. In years 2015, 2018, and 2021 there is no annual compliance obligation for the preceding compliance period, only a triennial compliance obligation. To fulfill a compliance obligation, a compliance instrument must be

issued from an allowance budget year within or before the year for which an annual compliance obligation is calculated or the last year of a compliance period for which a triennial compliance obligation. (ARB Article 5, 2013, p. 99)

If an entity fails to meet its compliance obligation, it must surrender “four times the entity’s excess emissions” (ARB Article 5, 2013, p. 101).

Compliance instruments are either California Carbon Allowances (CCAs), or California Carbon Offsets (CCOs). Covered entities are either allocated allowances for free, or purchase allowances at the auctions. The amount of allowances allocated for free depends on factors specific to the industry in which the covered entities operates. Large industrial facilities are generally allocated free allowances equal to roughly 90 percent of average emissions “based on output-based allocation methodology” that differs between industrial sectors and benefits efficient facilities. (ARB Article 5, 2013, p. 112)

Industrial allocations are more generous for sectors that have a higher leakage risk, or the risk of business relocating outside of California due to emissions requirements. Electrical distribution utilities are allocated 97.7 million allowances multiplied by a cap adjustment factor based on long-term procurement plans for years 2013-2020. After allowances are issued through the auctions, they are then bought and sold on the secondary market, the Intercontinental Exchange (ICE). Covered entities can bank allowances to hedge their future emissions exposure, but there is a holding limit established by ARB to prevent excessive hoarding of allowances.

Carbon offsets, on the other hand, are greenhouse gas reductions created through projects that sequester emissions from the atmosphere, or prevent the release of these emissions in the first place. These offsets are either compliance offsets or early action

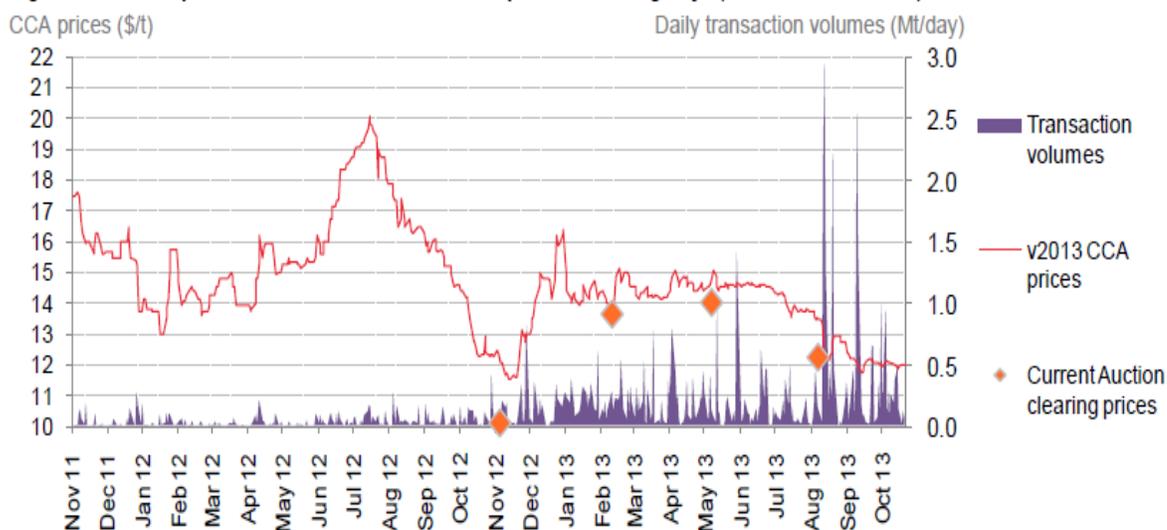
offsets (CRTs). The latter involves projects established from 2005 through 2013. Companies or landowners develop these projects, and apply to the two official offset registries: the Climate Action Reserve (CAR) and the American Carbon Registry (ACR) to obtain Registry Offset Credits (ROC). Once ACR or CAR issues a ROC, it then must be verified by ARB who issues Air Resource Board Offset Credits (ARBOC). These offset credits can then be purchased by companies to satisfy up to 8 percent of their compliance obligations. Offset projects are initially limited to four areas: forestry, urban forestry, dairy digesters and the destruction of ozone-depleting substances. Offset projects must operate in the United States. Offsets generally trade at a discount to allowances, and can provide the emission credits needed to fulfill compliance obligations once a compliance entity exhausts its allowances. The disadvantage of offsets is that they carry an invalidation risk, meaning that an offset can be invalidated up to 8 years after ARB issued the offset credits. An ARB offset credit may be sold, traded, or transferred, with the purchaser assuming liability for invalidation.

Market History and Forecasts

Carbon prices in California have fallen from their peak of \$14-15 a ton to a low of \$11-12/t. The highest auction settlement price was \$14/t from the May 2013 auction, and the lowest came in the most recent November auction at \$11.48/t. Prices rose initially in the program due to entities over-procuring allowances to hedge their future exposure. Since then, the market perception has been increasingly bearish, with prices steadily decreasing. Transaction volumes have been spotty throughout the duration of the program, thus the market is still relatively illiquid. The graph below displays price and

volume information through the end of October. Auction data from the 5 auctions can be found in Appendix B.

Figure 1: Carbon prices and transaction volumes – past 500 trading days (Oct 2011 – Oct 2013)



Source: Bloomberg New Energy Finance, InterContinental Exchange (ICE)

[Click here for underlying data](#)

The current forecasts for the remainder of the decade predict allowances prices to remain at or slightly above the price floor through 2019. Prices should rise during Q4 2014, however, with demand for allowances spiking “as transportation fuel suppliers enter the market a quarter early to purchase at the lower floor price and build up their hedging portfolios” (Nelson and Regan, 2013, p. 16). Prices will only begin to change in 2020 as entities realize the potential shortage of allowances in 2025. This is still largely to be determined, as allowance demand will be highly correlated with the post-2020 cap.

A steep declining cap would cause significant shortages in the market, and allowance demand would surge in 2020. If the cap stays flat, however, covered entities will satisfy compliance obligations easily, with no abatement necessary. The market would follow a similar pattern of oversupply post-2020, as it is currently is doing now. The graph below shows forecasted spot prices assuming different post-2020 cap

scenarios:

Figure 13: CQCA spot prices, by forecasting model, 2013-20 (\$/t)



Source: Bloomberg New Energy Finance, ICE

[Click here for underlying data](#)

Table 4: BNEF forecast CQCA spot prices, 2013-20 (\$/t)

Price tracks and forecasts	2013	2014	2015	2016	2017	2018	2019	2020
Auction floor price	10.71	11.41	12.20	13.09	14.00	14.98	16.03	17.15
MTM price forecast	11.30	12.36	13.18	14.08	15.01	16.03	17.09	18.17
GE2M price forecast	10.71	11.41	12.20	13.09	14.00	14.98	16.03	24.07
BNEF 'blended' forecast	11.30	12.36	13.18	14.08	15.01	16.03	17.09	24.07

Source: Bloomberg New Energy Finance

Offset supply began in September of this year, as ARB issued its first offset credits to four ozone depleting substances (ODS) projects. Since then, ARB issued credits to a total of twelve ODS projects, two livestock digester projects, and two forestry projects. The total number of offset credits issued by sector is outlined below, and the details of the projects by sector are listed in Appendix C.

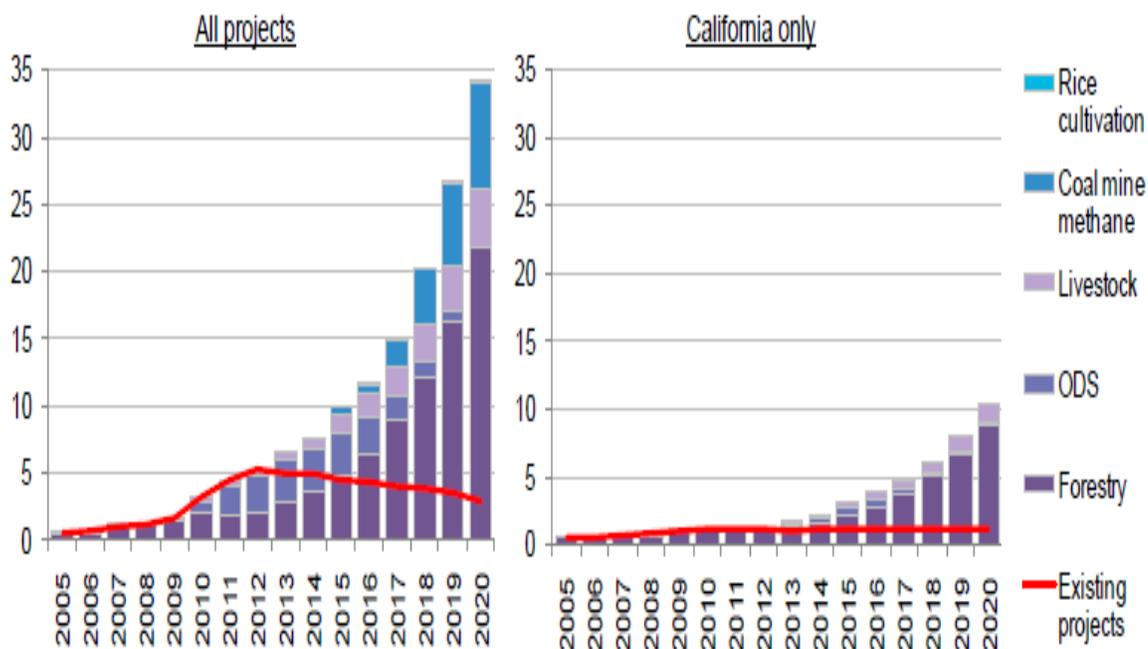
Project Type	ODS	Livestock	US	Urban
		Digester	Forests	Forests
Compliance	520,655	--	--	--
Early Action	1,325,287	31,348	1,360,806	--

Offset issuance will increase throughout the decade. Offsets are one of the most scrutinized aspects of the cap-and-trade program, and the initial offsets issued were rigorously examined by ARB. Belinda Morris, a director for the American Carbon Registry (ACR), asserts that ACR and the other official offset registry, the Climate Action Reserve (CAR) have multiple approved projects in the pipeline waiting for ARB approval. She believes that the issuances of offset credits for these projects from ARB will become more frequent, as ARB develops more trust with the registries' rigorous examination of offset projects.

Currently there are 2 Early Action Offset Projects, and 11 offset projects that have been issued ROCs by ACR, but are awaiting the conversion of these ROCs to ARBOCs by ARB. The average time for the conversion of ROCs to ARBOCs has historically been around six months. The details on ACR's approved projects, less the amount of ROCs issued, are shown in Appendix C. The Climate Action Reserve (CAR) has multiple projects in the pipeline as well. The type of approved offset protocols will also increase. There are currently two new proposed project types, rice cultivation projects and mine methane capture projects, which will most likely be approved in the near future. In aggregate, Bloomberg New Energy Finance estimates some "156Mt of offset supply to hit the market through 2020" (Nelson and Regan, 2013, p. 16). Their projections are

graphed below:

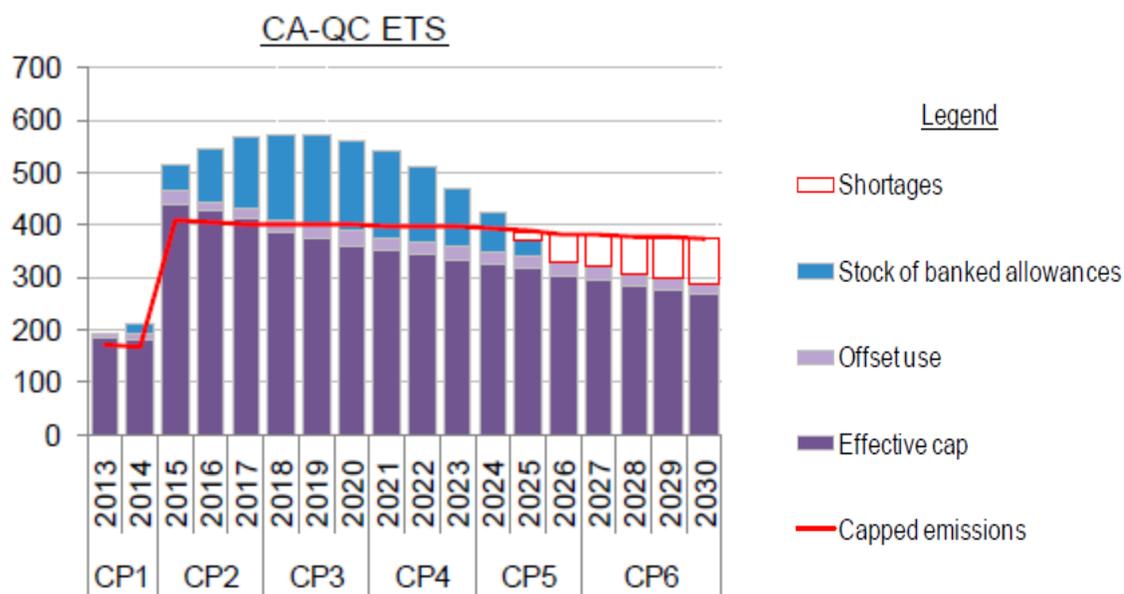
Figure 6: California-eligible offset supply forecast by protocol and issuance date, 2005-20 (Mt)



Source: Bloomberg New Energy Finance, Climate Action Reserve (CAR)

[Click here for underlying data](#)

Emissions rose about two percent from 2011 to 2012 due in large part from the increased electricity generation stemming from natural gas. This increase is the result of the San Onofre Nuclear Generation Station (SONGS) shutting down, and decreased rainfall in 2012 that reduced the amount of hydroelectric generation. This increase was partially offset by the substitution of imported power from natural gas instead of coal-fired generators (Glickman, 2013). Emissions data provided by ARB from 2008 to 2012 is listed in Appendix C. Emissions are expected to decrease at a slow rate from now until year 2030, with covered entities becoming short in the market in year 2025. BNEF's emissions projections, relative to compliance instruments are shown on the next page, and the comprehensive list of projected emissions for different sectors in year 2020 by ARB is presented in appendix C.

Figure 19: Market balance, 2013-30 (Mt)

Now that this study presented the history and current forecasts for the California cap-and-trade market, the paper will discuss scenarios that can change the current market forecasts. These changes are classified into three categories. The first describes scenarios that pose significant threats to the market's existence. The second reports scenarios that increase supply and place downward pressure on prices. The third details scenarios that increase emissions, cut supply, and increase demand for and prices of compliance instruments in the market.

POTENTIAL MARKET DISRUPTIONS

Threats to the Market Existence

On November 13, 2012, just before the first auction in the cap-and-trade market was held, The California Chamber of Commerce and tomato processor Morning Star sued the California Air Resource Board on the grounds that ARB does not have the right to auction allowances. The lawsuit failed in a ruling recently issued in November by California Superior Court Judge Timothy Frawley. He writes:

The court does not find Petitioners' arguments persuasive. Although AB 32 does not explicitly authorize the sale of allowances, it specifically delegates to ARB the discretion to adopt a cap-and-trade program and to 'design' a system of distribution of emissions allowances. (Volcovici, 2013, p. 3)

Despite this ruling, however, the CEO of the California Chamber of Commerce, Allan Zaremberg, disagreed with the ruling and indicated an appeal was probable. He claims that, "It is ripe for review and reversal by the appellate court" (Volcovici, 2013, p. 3).

The other related case filed by Morning Star against ARB argues that the sale of allowances is a tax, which the legislature must pass by a two-thirds majority vote, pursuant to Proposition 13. The court shot down this argument as well. The Environmental Law Reporter (ELR) outlines the reasoning below:

The primary purpose of the charges is regulatory, the proceeds must be used to further the regulatory purposes of AB 32, and, even if selling allowances is not "necessary" to achieve AB 32's goals, selling allowances may still advance those goals. In addition, the total amount of fees collected will not exceed the costs of the regulatory activities they support, and there is a sufficient nexus between the fees charged and the regulatory burden imposed by the fee payers' products or operations. (ELR, 2013, p. 1)

Although both of these court decisions went in ARB's favor, they are subject to an appeals process, which is probable. Auctions are ARB's mechanism for establishing the floor price, and without them, prices would likely fall below the floor price. Some traders placed sub-floor put options since the start of the program. The majority of these puts were ordered at the beginning of the program, when the future of cap-and-trade was still

largely uncertain. However, there are still outstanding sub-floor puts that are essentially betting on the outcomes of these lawsuits. If prices fall below the strike price, these puts would exercise and cause prices to fall. In addition, arguably the most integral activity in the cap-and-trade program, the auctions, would disappear. The program would in effect fail, and entire market's existence would come into question.

Outside of these lawsuits, the only real threat to the market's existence is a change of leadership from current governor Jerry Brown. It would be very difficult for the state to dismantle the program, given the broad political support for emissions reductions in California, and the money already invested by business in the program, and received by the government. However, if the program became too much of a burden to business, and the economy began faltering, a new governor could be elected on the premise of restoring economic stability by reducing costs to business from emissions requirements. This type of political change occurred in Australia earlier this year, with the election of the conservative Prime Minister Tony Abbott who is seeking to eliminate the previous administrations climate policies, which included a carbon tax and the basis for a cap-and-trade system (Anderson, 2013).

Bearish Scenarios: Emissions Reductions

Bearish prices are correlated to falling emissions, as lower emissions decrease demand for compliance instruments, thus increasing the current supply demand imbalance. Cap-and-trade is just one of a number of state requirements that require emissions reductions. California has a Renewable Portfolio Standard (RPS) that requires 33 percent of electricity generation to be from renewable sources. Governor Brown recently approved AB 327 in October, which "grants the California Public Utilities

Commission (CPUC) the authority to expand the state's RPS beyond 33%" (Nelson and Regan, 2013, p. 8). The CPUC may not even need to force the expansion of the state's RPS on utilities. Two senate bills, SB 43 and AB 1014, propose shared renewable energy projects between the three largest utilities: PG&E, SCE and SDG&E. The bills "would allow the 75% of California utility customers who can't install their own on-site generation to subscribe to "shared" renewable energy projects" (Clean Technica. 2013, p. 1). This legislation is notable because it allows the green-minded California consumers the capacity to directly reduce emissions. Large scale renewable projects would be easier to finance with costs shared by the three largest utilities, which stand to make substantial profits from these projects. The bills passed the CPUC by a 9-0 vote, and will be heard in the legislature next year. The CPUC will define specific methodologies by 2015, and complete an 18 month pilot program sometime thereafter. Shared renewable generation would most likely replace more energy intensive power, like coal and natural gas, thus decreasing emissions from the electrical distribution sector. The CPUC believes that up to 12 GW could be produced from distributed solar sites. Although this would take time to develop, this is an immense amount of clean energy that would decrease emissions significantly. Demand for allowances from the utility sector would be even weaker than current projections, and future allowances prices would drop.

Another program that decreases emissions is the current requirement that 15 percent of new car sales by 2025 must come from zero emissions vehicles (ZEV). Currently, about 38 percent of California's emissions come from fuel vehicles. This ZEV requirement, consumer demand for ZEVs and potentially higher gasoline prices drive the sales of hybrid and fully electric plug-in vehicles. The emissions from automobiles are

classified as mobile sources of emissions, which are not covered under the cap-and-trade program. The emissions reductions would affect transport fuel suppliers instead, which are covered beginning in 2015. This industry already has a generous cap, so the decreased demand for gasoline would make the industry's compliance obligations painless. The additional electricity demand fueled by electric cars would be met by utilities at night, when they offer lower rates, and can satisfy electricity demand with the cleanest sources possible.

ARB currently has some proposed regulatory amendments that were first raised in July, and subsequently heard in Board hearing in October. Two of the amendments add to the oversupply of the market projected to occur for the remainder of the decade. The first deals with the controversial issue of resource shuffling, which allows electrical distribution utilities to selectively source their imported power. ARB struck a compromise with utilities that could result in a significant amount of emissions leakage, but will ensure California's supply of electricity. Some opponents believe "the volume of leakage associated with these new regulations is comparable to the volume of mitigation required by the entire cap-and-trade program" (Nelson and Regan, 2013, p. 7). The other major amendment gives industrial emitters certain "industry assistance factors" that raise their cap during the second compliance period. Both of these measures have negative effects on prices, as demand for allowances will decrease. A final decision on both these measures will occur in the spring of 2014.

Bearish Scenarios: Increased Offset Supply

A significant increase in offset supply raises the amount of compliance instruments available in the market for covered entities. As indicated previously, an

estimated 150-160Mt of offset supply is expected to hit the market through 2020. This number, however, could in fact be higher if certain scenarios were to come to fruition. Belinda Morris, a director from the American Carbon Registry, opined that forestry is the offset sector with the most long term growth potential, but also the most problematic. This analysis delved into what these problems are, and David Diaz, a forestry program manager at Eco Trust, asserted that ARB's forest offset protocol is very costly for forestry land owners. The costs are to the point that only roughly 10 percent of available forestry landowners, those that have acreage in the thousands, could economically generate offsets. Diaz and others in forestry are working to lessen the rigor of ARB's regulations. If certain methodologies are adopted, as they are in offset protocols outside of California's system, investment firms could aggregate multiple small-scale projects to produce offsets. This would open the door for the other roughly 90 percent of available forestry to generate offsets. This change to ARB's forestry protocol would not occur in the near term, but could be adopted in the long term, when there is a higher probability of a shortage in the market. Forestry offsets trade at the largest discount to allowances because of the high risk of invalidation, but this spread would narrow with more demand.

There is evidence of the development of other offset project types, many in the agricultural sector. The Climate Trust, an Oregon based carbon finance non-profit, offered offset developers an opportunity to submit Requests for Proposals (RFPs) for new projects. They received over 25 submissions that sought over \$47 million for new types of offset projects. Sheldon Zakreski, Director of Programs for The Climate Trust, asserts in regards to the agricultural sector, "This may be a signal that the sector is maturing and taking steps to become a meaningful contributor in the offset market" (Krifka, 2013, p.

1). The problem, however, lies in the lack of potential buyers, but this could very well increase going forward in the event of a market shortage. In addition, offset supply could increase with the aggregation of small agricultural offset projects.

One of the problems covered entities have with using offsets to satisfy their compliance obligations, is that the liability of offsets being invalidated—which can occur up to 8 years after their issuance—is incurred by the buyer. Adding to the problem, the developer of these offsets often times do not have sufficient credit worthiness for buyers. Some companies are finding ways to solve this problem. In May of this year, the U.K. based Parhelion Underwriting Ltd. Firm began offering insurance for “the risk of invalidation of ARBOCs, removing the financial risk associated with this from the holder of the offsets” (Business Wire, 2013, p. 1). Most offset developers do not have investment grade credit, so companies with sufficient credit are purchasing offset projects to sell to compliance entities with credit restrictions on their offset purchases.

Investor Owned Utilities have their own set of problems in the offset market. IOUs are not allowed to purchase offset credits on a forward basis, and they also must undertake a lengthy and burdensome Request for Offset (RFO) process to purchase offsets. The two largest Investor Owned Utilities, Southern California Edison (SCE) and Pacific Gas & Electric (PG&E) issued RFOs. Experts believe, however, that these RFOs were done to demonstrate how inefficient and lengthy the RFO process is, and show the California Public Utilities Commission that the process needs to be changed. Currently, IOUs and other market players such as brokers are working to facilitate this change. This change is expected to occur in 2014, and would result in more IOU participation and liquidity in the offset market. IOUs comprise a large portion of the market, and if they

can utilize offsets, which trade at a discount to allowances, to satisfy up to 8 percent of their compliance obligations, their demand for allowances would decrease.

Bullish Scenarios

There are some possible regulatory catalysts that would increase demand for allowances and drive prices up. ARB could reduce the amount of free allocations it doles out, decrease the percentage of allowances in a company's compliance portfolio that it can bank for future use, or restrict the supply of offsets. ARB's historical stance, however, reflects quite the opposite. The allowance budget imposed by the board is generous, as market forecasts predict covered entities to have little trouble meeting compliance obligations through 2020. In addition, the majority of amendment changes, like the resource shuffling and transitional assistance factors mentioned previously eases the compliance burden for covered entities. In a personal interview conducted for this analysis, Morgan Hagerty, a director at CE2 Carbon Capital, asserted that, "if there is a change, it is usually an industry favor unless there is a huge oversupply." The Regional Greenhouse Gas Initiative (RGGI) is an exception to this rule. RGGI is the cap-and-trade market for power providers in nine Northeastern states. Earlier this year, the RGGI cap was reduced "from 165 million to 91 million tons—a reduction of 45 percent. The cap would decline 2.5 percent each year from 2015 to 2020" (Brown, 2013, p. 1). If covered entities show no real abatement efforts before 2020, ARB could implement a similar program. This would encompass a steep post-2020 cap that would induce a market perception of future allowance scarcity, and increase demand for allowance in the third compliance period. The deadline for the announcement of this cap is likely to be the end of 2017, according to a recent ARB proposal.

Another scenario that could play out deals with a bill that threatens to restrict offset supply to projects listed in California. The senator behind this bill pledged to amend the bill's language, but the amendments have yet to be written. Ending out of state offsets would effectively reduce offset supply by roughly 70 percent. In the absence of a significant portion of the offset market, covered entities would have to use more allowances to satisfy their compliance obligations, driving up demand and prices. This bill is unlikely to pass, however, especially due to the fact that out of state offsets have already been issued. Other scenarios that would hamper the offset market include lawsuits from environmental groups who largely oppose the inclusion of offsets in cap-and-trade, and any legal requirements to make certain types of offset projects mandatory for the industries that produce them. An example of the latter would be a legal requirement for the agricultural industry to use livestock digesters in their operations.

The establishment of other cap-and-trade programs in jurisdictions outside of California, and the subsequent linkage of these programs with California would have a significant effect on the market. Beginning in January 2014, Quebec is linking with California. Air Resource Board chair, Mary Nichols, said, "Linking the programs will provide a framework for additional partners to join and demonstrate a workable template for urgently needed climate action" (Carroll, 2013, p. 1). Oregon, Washington, British Columbia, Ontario and others in the Western Climate Initiative (WCI) could potentially develop cap-and-trade programs. These areas procure the majority of their electricity from hydropower, a clean source of electricity. The initial allowance allocations and caps for Quebec, and potentially other jurisdictions, is generous. That said, further emissions

reductions would prove difficult, given their clean energy profiles. This positions them as net buyers of allowances, and would make the market short in the long-term.

The other bullish scenarios relate to emissions data reported higher than expectations. In the short term, this could result if 2013 emissions rise above forecasts. Future years with a low amount of annual rainfall, which occurred in 2012, decrease hydropower generation, increasing emissions from dirtier sources. This increases demand for allowances from the power sector in the short term. There are several long term scenarios which could result in emissions increases that currently are not accounted for in the market. The following two sections will explore two of these scenarios at length: the shutdown of the Diablo Canyon nuclear power plant, and a boom in oil production from the Monterey/Santos shale.

SHUTDOWN OF DIABLO CANYON NUCLEAR POWER PLANT

The Diablo Canyon nuclear power plant coming offline permanently, or for a significant period of time would eliminate the largest source of clean energy in California. The plant is owned by PG&E and produces 2.3 GW of electricity, or roughly 10 percent of the state's electricity. Emissions would increase significantly, and induce a rise in allowance prices. The reasoning behind a Diablo Canyon shutdown relate to environmental considerations, and the ability of the plant to operate safely given major disruptions from earthquakes.

Causes of Diablo Canyon Shutdown

The plant currently uses 2.5 billion gallons of water in its once-through cooling process, which returns artificially hot water back into the ecosystem. This process

negatively affects the aquatic ecosystem, with the major concern being the amount of fish larvae killed. This is a problem for other coastal power plants, and

On May 4, 2010, the state Water Resources Control Board adopted a policy requiring all 19 coastal power plants in California to reduce by 93 percent the amount of damage their once-through cooling systems cause. State regulators have given PG&E until the end of 2024 to comply with the new rule” (Sneed, 2013, p. 1).

There is also federal pressure on the operations of Diablo Canyon. First off, “federal regulators are requiring about \$50 million in safety equipment at Diablo Canyon in the aftermath of the Fukushima nuclear disaster in Japan” (Sneed, 2013, p. 2). In addition, PG&E must decide whether to renew the two operating licenses on the plant, with one set to expire in 2024, and the other in 2025. Diablo Canyon is exploring ways to transform this once-through cooling process to solve its environmental problems. PG&E hired the engineering firm, Bechtel, to develop possible solutions. The firm’s recommendations, including cooling towers, offshore pipes and mesh intake screens, pose serious obstacles. First off, the estimated costs are in the hundreds of millions and billions of dollars. Moreover, these solutions all come with other negative environmental impacts, use many untried techniques, increase electricity rates substantially for ratepayers, would take roughly 17 months to implement, and have no guarantee of meeting the 93 percent damage reduction threshold set by the state. Because of these challenges, California’s once-through cooling nuclear review committee, “recommends that the state allow the continued use of once-through cooling at Diablo Canyon until the end of 2025, then require the plant to shut down when its license expires” (Sneed , 2013, p. 3). The method

chosen must be implemented to the nuclear plant by 2024, and the costs associated with the change will be passed onto ratepayers.

There are two other possible situations in which the plant could be shut down prior to 2025. These two situations relate to the fault lines near the nuclear plant, and the possibility of an earthquake causing devastating consequences to the power plant and the areas surrounding the plant. According to a report published in November by the Union of Concerned Scientists (2013), “The Nuclear Regulatory Commission (NRC) is not holding the Diablo Canyon nuclear plant to the same standards it requires of every other nuclear facility to address potential earthquake hazards“ (p. 1). These standards stem from the information Pacific Gas & Electric (PG&E) provided the NRC in 2008 surrounding “a previously unknown earthquake fault line running as close as 2,000 feet from Diablo Canyon’s two reactors that could cause more ground motion during an earthquake than the plant was designed to withstand. Since this new fault was discovered, the NRC has not demonstrated that the reactors meet agency safety regulations” (p. 1).

The Union of Concerned Scientist’s report, *Seismic Shift: Diablo Canyon Literally and Figuratively on Shaky Ground*, details the history of the Diablo Canyon’s estimates for seismic safety. There are two levels of federal regulations on earthquake hazards. Level one is the Operating Basic Earthquake (OBE) and level two is the Safe Shutdown Earthquake (SSE). The SSE level measures “the integrity of the reactor coolant boundary, and the capability to shut down the reactor and maintain it in a safe shutdown condition.” (Lachbaum, 2013, p. 2) This level is under scrutiny, and is currently set at 0.4g, where g represents acceleration due to gravity, and in a general sense, ground motion. According to the report, this 0.4g level has been in question since

the discovery of the Hosgri fault in the mid-1970s, which lays about three and a half miles offshore of the power plant. After this revelation, the NRC required PG&E and their Long Term Seismic Program (LTSP) to “evaluate the plant’s response to 0.75g ground motion resulting from an earthquake occurring on the Hosgri fault” (Lachbaum, 2013, p. 6). PG&E concluded that the plant could withstand this type of earthquake, but the UCS points out that non-standard methods and non-conservative assumptions were used in this evaluation. Earthquakes can produce larger ground motion than 0.75g, however, and “the chance such a large earthquake will occur at Diablo Canyon over the 40-year lifetime of the plant is 40 divided by 256, or about 1 in 6” (Lachbaum, 2013, p. 8).

Three years after the discovery of the shoreline fault, on October 20, 2011, “PG&E submitted a license amendment request to the NRC seeking to revise the seismic design bases for Diablo Canyon. Specifically, PG&E requested that the NRC approve increasing the SSE level to 0.75g—the Hosgri earthquake level” (Lachbaum, 2013, p. 10). During the investigation, “Dr. Michael Peck, the NRC senior resident inspector assigned full-time at the Diablo Canyon site, disagreed with preliminary conclusions by PG&E and the NRC that Diablo Canyon could continue operating safely with these seismic issues unresolved” (Lachbaum, 2013, p. 10). Among the system prevention measures that he saw ineffective, were the reactor vessel and piping attached to it that cool the reactor core and prevent its meltdown. This dissention was ignored, however, and on “October 25, 2012, PG&E formally withdrew its license amendment request from the NRC” (PG&E 2012). So ultimately, the SSE value remains at 0.4g, and the plant remains operational despite the apparent seismic protection gap. This explains why out

“of the 100 reactors currently operating in the U.S., the two at Diablo Canyon top the NRC’s list as being most likely to experience an earthquake larger than they are designed to withstand” (Lachbaum, 2013, p. 7).

The reasoning behind the plant’s continued operations amidst questionable regulation on behalf of the NRC is the massive revenue and electricity generated by the plant. PG&E commissioned a report that states the Diablo Canyon plant “contributes approximately \$920 million annually to the economies of San Luis Obispo and northern Santa Barbara Counties” (Friedman, 2013, p. 1). The tax revenues are also substantial, with money going towards the county fund and local school districts. The sheer amount of electricity generated from the plant is substantial, and bodes well for the plant’s continued operations. 10 percent of the state’s electricity and 23% of PG&E’s electricity stems from the plant. Thus, the functional benefits of the plant are not in doubt. That said, the safety of its operations remain in doubt.

The UCS report was released on November 4, 2013. Given the nascent nature of this report, there is a possibility that the plant is shut down until further safety preventative measures are implemented at the plant. In the wake of the Fukushima disaster in Japan, the NRC issued a series of orders and recommendations for Diablo Canyon on March 12, 2012. The order includes seismic re-evaluations and walkdowns, flooding re-evaluations and walkdowns, among other measures. Diablo Canyon must complete these measures by March 2015 (California Energy Commission, 2013). This could be a crucial milestone in the decision-making process for PG&E in whether or not they will renew their operating license, which expires in 2025. Alternatively, the results combined with further operational problems and public dissention from environmental

groups could force the shutdown of the plant either temporarily, or permanently. The chances of a plant shutdown would increase even more if there is any sort of nuclear disaster or scare in other parts of the world, or if a significant earthquake occurs in California. Not only would the safety of Californians be in jeopardy, but the negative supply shock on California's electric utilities would result in considerable changes to the cap-and-trade market.

Effects on cap-and-trade market

As discussed previously, there is definitely a possibility that the Diablo Canyon nuclear power plant shuts down before the current end of the cap-and-trade program, 2020. Most experts believe the program will be extended beyond 2020, and the more probable shutdown of the plant due to the expiration of its license, would occur in 2025. Thus, the implications of this shutdown must be considered in the context of the market, emissions, and prices of allowances.

The replacement power for Diablo Canyon would come in large part from natural gas. According to interviews conducted with an analyst from Bloomberg New Energy Finance and a senior director of Evolutions Markets, 7 or 8 million tons of carbon dioxide would be added to California's emissions annually in Diablo Canyon's absence. In a company specific context, Pacific Gas & Electric would have to replace 23 percent of their California electricity generation. Substituting power generation from more emissions intensive sources would increase their demand for compliance instruments.

PG&E and other investor-owned utilities have some of the most sophisticated banking and hedging strategies, as they can project their electricity deliveries three years out with a relatively high degree of certainty. A Diablo Canyon shutdown prior to the

expiration of its license in 2024 is an uncertain and unexpected event. Diablo Canyon's unit 1 reactor was shut down for a week in June when PG&E found a leak in it, and any further operational problems could lead to an official NRC investigation, requiring a temporary shutdown. If this were to occur, PG&E would replace its power generation with natural gas sources, and their emissions for the year would increase. PG&E could apply some of their banked allowances to cover the increased emissions, but would inevitably have to purchase more allowances on the secondary market or on the auction. It would be very difficult for PG&E to use offsets to cover these excess emissions, due to the lengthy RFO process which may or may not be resolved, and the nascent nature of the offset market.

The March, 2015 deadline for Diablo Canyon to complete its post-Fukushima assessments could fall at the same time the plant decides whether or not to renew its license in 2024. If PG&E decides to shut down the plant, it would most likely follow a similar planned shut down as the San Onofre Nuclear Generation Station (SONGS) did. SONGS was officially slated for retirement on June 7, 2013, ending a year and a half saga of uncertainty. During this time period, it appears that the market accounted for the shutdown, as it had little effect on prices. It did, however result in the "third-most liquid trading day in the California carbon market's history" (Nelson and Regan, 2013, p. 2). If an investigation occurs that questions the plant's ability to operate in the future, the market would begin to factor in the increase of emissions into its prices. Prices would increase in the long term, and volumes would increase in the short term after major announcements such as a temporary or permanent shutdown.

The current demand gap for allowances would decrease by 7 million tons annually. Currently, Bloomberg New Energy Finance estimates this imbalance at the end of 2013 to be “-23Mt, meaning that (i) allowances sold at auction and (ii) offset credit issuance, summed together, outnumber immediate and hedging demand to date by 23 Mt” (Nelson and Regan, 2013, p. 14). This imbalance hovers around 20-25 Mt until demand outstrips supply in 2019. The imbalance would narrow to roughly 15 Mt with a Diablo Canyon shutdown. The increased demand would affect prices on the secondary market and auction prices. If the plant goes offline during the first compliance period, in 2014, the added emissions represent roughly 4.7 percent of the annual allowance budget. This 4.7% could be logically multiplied to the price of allowances for 2014, 12.36 which comes from BNEF’s blended forecast, producing a price above \$13. For the second and third compliance periods, the added emissions represent a smaller percentage of the allowance budgets, due to the expansion of the entities covered beginning in 2015. The effect of the shut down on prices would be smaller in aggregate.

One interesting possibility that could intensify the effect of a Diablo Canyon shutdown on the market deals with the increased price volatility in an auction due to one entity bidding on a large quantity of allowances. Given the general oversupply of allowances through 2020, many entities will be hoarding allowances and banking them for future use. If more companies are comfortable with their compliance portfolio, and choose to not participate in the auctions, there will be a smaller amount of potential sellers and smaller volume available. Moreover, IOUs could consign no allowances in the first auctions of any given year, and consign all of them in the last auction of the year. Thus, “some auctions may have fewer allowances than bids, with a high clearing price”

(Southern California Public Power Authority, 2012, p. 1). If PG&E goes to the market with large orders for allowances to offset the shutdown of Diablo Canyon, and PG&E is fearful that they will not be able to acquire the amount they need, the utility will place a higher price in its bid orders to guarantee the acquisition of allowances. The auction settlement price would increase significantly.

If PG&E chooses to shut the plant down, it will increase investment in abatement, such as renewable energy projects. These types of investments would have to be evaluated against the post-2020 allowance cap, which is in question until the end of 2017. If a steep cap is implemented by ARB, the costs of shutting down PG&E's largest clean electricity generation facility would increase. Although new renewable projects could fulfill some of this need, it won't be able to satisfy all of it. Compliance instruments must be utilized. PG&E could focus more on the offset market to satisfy up to 8% of their compliance obligations, if the requirements of their RFO process become less stringent. Brokers and market participants are working to change the RFO process, and this could occur in 2014. Offsets are outside of the allowance cap, and a large forestry project could provide a strong stream of offsets for PG&E to use until effective abatement strategies are implemented. Forestry offsets trade at a higher discount to allowances, because of the increased uncertainty and invalidation risks associated with them. This spread could narrow with large purchases by PG&E.

The timing of a Diablo Canyon shutdown due to license expiration comes at the same time analysts believe demand for allowances will outstrip supply. Bloomberg New Energy Finance analysts Colleen Regan and William Nelson write:

We expect that emissions will fit neatly under the cap until 2017, allowing the market to carry over a surplus of 175Mt of allowances into the third compliance period. But a steeply declining cap could cause entities to quickly exhaust their banks, and real shortages will occur after 2024 in the absence of abatement at costs about the auction floor price (2013, p. 1)

A Diablo Canyon shutdown would intensify this shortage, and add to market demand. Whether or not ARB would account for this shutdown with a more generous post-2020 cap for IOUs is still in question. If they did, the bullish effect of a Diablo Canyon shutdown would decrease.

The next section outlines an enormous change in the California energy industry that would cause emissions to skyrocket. This is the possibility of a boom in oil and gas production from the Monterey/Santos shale.

SHALE OIL BOOM FROM MONTEREY/SANTOS TIGHT OIL FORMATION

The extraction technology in the oil and gas industry has drastically expanded in the past decade, primarily due to the practice of hydraulic fracturing, or “fracing”, and horizontal drilling. Fracing is a highly contentious extraction technique that has transformed previously unattainable oil and gas reserves into gold mines for the companies and states that produce them. States such as Texas, North Dakota, Wyoming, Pennsylvania, and Ohio have revitalized their economies in large part through this newfound oil and gas production. Oil companies in California are testing these new production techniques in the oil rich Monterey/Santos shale, in hopes of increasing the state’s oil production.

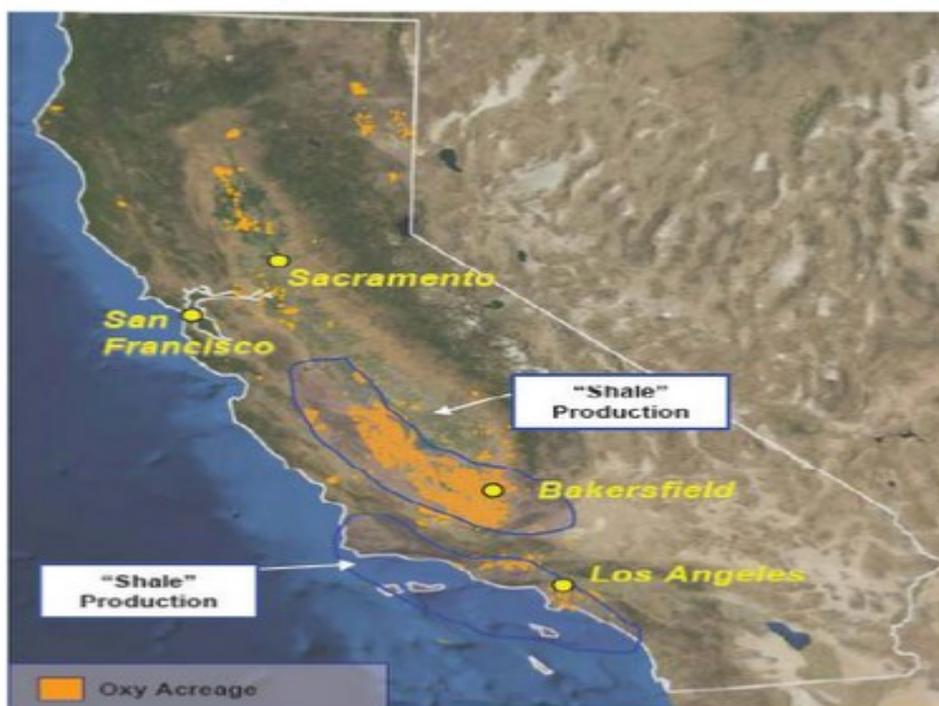
California Oil and Gas Production

California is historically one of the largest oil producing states in the nation. The most recent data from the EIA for 2011, ranked California:

...Third in the Nation in crude oil production in 2011, despite an overall decline in production rates since the mid-1980s. California also ranked third in the Nation in refining capacity, with a combined capacity of almost 2 million barrels per calendar day from its 20 operable refineries (EIA, 2012)

California is blessed with the largest shale oil formation in the United States. The EIA estimates that the Monterey/Santos play contains 15.4 billion barrels of technically recoverable oil. The total reserves of the state are estimated around 400 billion barrels, which is roughly two thirds of the entire estimated U.S. shale oil reserves (EIA, 2011). The Monterey shale play is the primary source rock for the conventional oil reservoirs found in the Santa Maria and San Joaquin Basins in southern California.

Figure 32 Monterey/Santos Shale Play



The Monterey/Santos is different from many other shale plays, such as the Marcellus in the Northeast, that hold primarily natural gas. The Monterey is a tight oil formation, and a behemoth of a shale play when compared to the other shale oil plays in the U.S. The Bakken in North Dakota and the Eagleford in South Texas are estimated to contain around 3.5 billion barrels of oil each. The tight oil production in the U.S. has skyrocketed due to technological advances. "U.S. tight oil production increased from an average 0.2 million barrels per day in 2000 to an average of 1.9 million barrels per day in 2012 for 10 select formations" (EIA, 2013). Given the current supply of natural gas from large, recent increases in domestic production, oil is a much more economic resource to drill for with its relatively high price. The Monterey contains mostly oil and liquid natural gas products, making the resources economically advantageous. The problem in the Monterey is that the unconventional techniques used to unlock oil in other shales cannot be identically applied to the Monterey. This is due to the broad spectrum of the shale's

geologic composition. The San Andreas Fault adds another difficult dimension to the shale, as it jumbles the rocks together, making them thicker. Thus, conventional fracking has not proved effective, but other methods like deep acid injection show some promise.

Fracing does not constitute a substantial portion of California's aggregate oil production. According to the Western States Petroleum Association, "only 560 of 50,000 producing wells were fraced in 2012" (Carlton, 2013, p. 1). Companies have not seen any major breakthroughs from fracing resulting in recoverable reserves. One major company in the region, Venoco, "said in a report that after drilling 29 wells in the Monterey Shale from 2010 to 2012, no material levels of production or reserves resulted" (Carlton, 2013, p. 2). The industry is optimistic about future production and technical breakthroughs, but the industry-wide focus will be on the easier shale oil plays in the Bakken and Eagle Ford, and will shift to the Monterey more in the future. Chevron's CEO John Watson states that, "I don't think we've completed—the industry has completed—the assessment enough to reach a conclusion" (Carlton, 2013, p. 3). Part of this industry assessment relates to the advanced technology, 3D Seismic, which produces detailed information on rock formations and areas of potential interest for production. This technology has yet to be dispensed on a large scale in the Monterey, and could give extractors the information needed to increase production in the Monterey.

Current Regulation on Oil and Gas Industry

Fracing is present in California and has historically been unregulated in the state. In the past year, however, it has been a focus of legislative activity. This past April, a bill was introduced in the California Legislature that called for a fracing moratorium, or an end to fracing, for the next five years. This time limit was then reduced to one year to

attract votes, but ultimately failed to pass. Governor Rick Brown vowed to never sign a fracing moratorium, and touted the economic benefits of the practice. This led to the elimination of virtually all the proposed fracing legislations, besides one, Senate Bill 4 (SB 4), authored by the Democrat Fran Pavley. On September 20, 2013, the bill passed, and is the first bill to regulate fracing in the state's history.

The bill is effective January 1, 2014 and drew criticism from both sides, as environmental groups continue to call for a fracing moratorium, and the oil industry wants to remain unregulated. The major regulatory provisions include:

Groundwater monitoring, a requirement that oil companies publicly disclose all chemical injections into the earth, the inclusion of well-stimulation techniques other than fracking in the regulations and a mandate for oil companies to get a permit before conduction fracking operations (Herdt, 2013, p. 2).

The permitting process was changed at the last minute, and begins January 1, 2015. The law requires a statewide environmental impact report (EIR) by July 15, 2015, pursuant to the California Environmental Quality Act (CEQA). In addition, it requires the Department of Oil, Gas and Geothermal Resources (DOGGR) "to adopt its rules and regulations governing fracing wells, disclosure, and operations" (Hein, 2013, p. 3) by January 1, 2015. Criticism of this portion of the bill points to the fact that oil companies will receive permits with ease until mid-2015. This is due to the interim "ministerial process for the issuance of fracing permits without additional CEQA review" (Einhorn, 2013, p. 3) described in the bill. Environmental groups filed a lawsuit against DOGGR in October of 2012 about this permitting process, but oil industry groups filed a motion on November 7, 2013 after SB4 passed that essentially invalidated the lawsuit. This lawsuit

has yet to be resolved, but in the meantime is in favor of the oil industry, and will probably not be resolved before the SB4 permitting process begins in 2015. Thus, for the next year and a half, there will be unregulated fracking in California.

A breakthrough could very well occur, as it did in 1998 when George Mitchell finally found a way to produce from the Barnett Shale. It just takes one company to hit the sweet spot, and the stage would be set for Monterey production to explode. If this were to occur, the outlook for cap-and-trade would experience an immense change.

Effect on Cap-and-Trade

A shale oil boom in California would undoubtedly increase emissions. The entities that bear direct responsibility for this increase are the fuel suppliers that will be included in the cap-and-trade program at the onset of the second compliance period, on January 1, 2015. The list of industries includes: suppliers of natural gas, suppliers of Reformulated Blendstock for Oxygenate Blending (RBOB) and distillate fuel oils, suppliers of natural gas liquids, suppliers of blended fuels, and carbon dioxide suppliers. Companies operating in these industries are responsible for each ton of Carbon Dioxide equivalent emitted above their 25,000 Mt/yr threshold. There are some emissions that are not included, however. Those that relate to the oil and gas industry are:

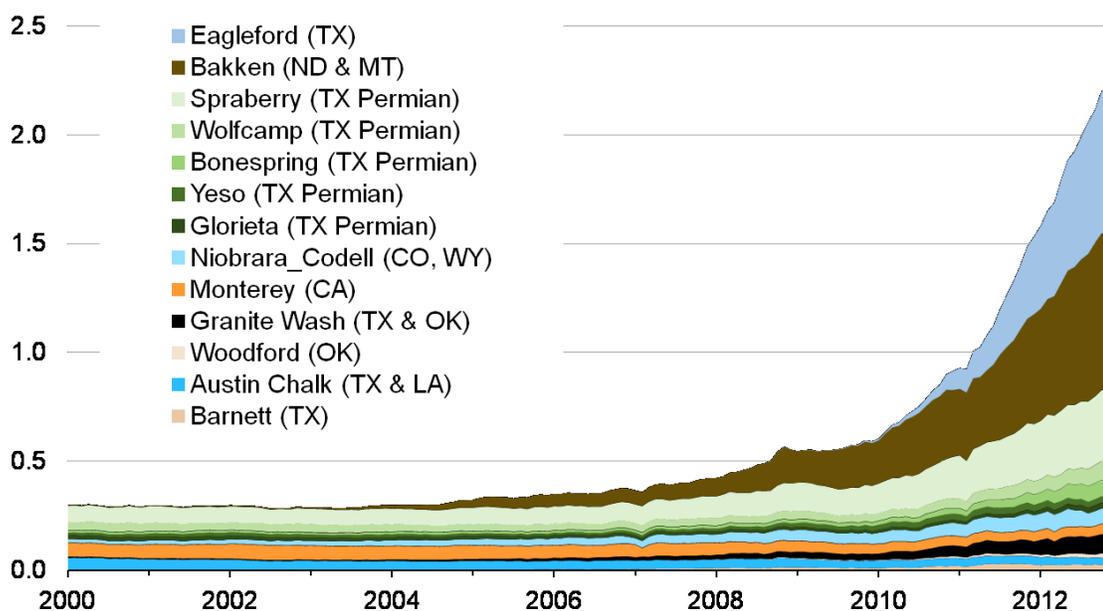
Vented and fugitive emissions from storage tanks used in petroleum and natural gas production; vented and fugitive emissions from local distribution companies; vented and fugitive emissions from natural gas transmission storage tanks used in petroleum and natural gas production and natural gas transmission, and from produced water; emissions reported by petroleum refineries from asphalt blowing operations, equipment leaks, storage tanks, and loading operations; vented

emissions from well-site centrifugal and reciprocating compressors with a rated horsepower less than 250hp; sources for which emission are estimated using leak detection and leaker emission factors; and carbon dioxide that is imported, or that is exported for purposes other than geologic sequestration (ARB Article 5, 2013, pgs. 95-96)

Vented and fugitive emission are those associated with leakage and unintended gaseous emissions. They are difficult to quantify and measure, so ARB took a conservative approach and decided to not include them in the program. They can, however, be a significant contributor to climate change and air pollution. The omission of these is yet another example of the generous policies ARB is allowing for the oil and gas industry. ARB did, however, remove a portion of its exempt emissions from previous regulations, offshore petroleum and natural gas production. This is significant considering the amount of offshore production in California. However, the SB4 fracking regulation excludes offshore production.

California oil is significantly dirtier and more carbon intensive to produce than oil from other areas in the world, like Alaskan light crude. This is due to the high sulfur content in the oil. In order to quantify how carbon intensive the process of extracting and refining oil is, this analysis takes the most recent EIA data for annual production from 2011 and 2012, and divides this number by the amount of greenhouse gas released due to oil extraction provided by ARB. This comes out to roughly 0.05 tons of CO₂e emitted per barrel of oil produced. Annual oil production in California dipped under 200 million barrels in 2011 and 2012, but if industry finds a way to tap into the Monterey, this number will skyrocket. Dan Clarke, a Los Angeles-based consulting geologist asserts

that: “Development of the Monterey Shale probably will follow the same pattern as most other shale plays in the United States. Sooner or later, one company will figure out the right approach to drilling, hydro fracturing and production” (Lusvardi, 2013, p. 2). Thus, this analysis will examine the rise in production from the Bakken Shale, a similar oil rich shale play, to predict the degree future oil production could increase if a technological breakthrough were to occur. The following graph shows the rise in domestic production from different tight oil plays.



Source: Drilling Info (formerly HPDI), Texas RRC, North Dakota department of mineral resources, and EIA, through December 2012

The Bakken developed slowly until technological breakthroughs doubled production from 2006 to 2010, and with the necessary infrastructure set, production nearly tripled two years later. Oil companies in California have the ability to continue testing production techniques without much government oversight until mid-2015. This analysis makes the hypothetical assumption that by 2015, a production breakthrough will

occur. From this point on, production will increase exponentially to 1 million barrels per day (Mbpd) by 2020. The analysis goes on to assume that production will increase at a faster rate post-2020, as the necessary infrastructure is established to handle more production. This faster rate results in production of roughly 2 Mbpd by 2025. The graph below displays the projections of this analysis:

Year	Added Production (mbpd)	Total Yearly Added Production (b/y)	Carbon Intensity	Increase in Emissions (Mt)
2015	0.3	109.5	0.05	5.475
2016	0.4	146	0.05	7.3
2017	0.5	182.5	0.05	9.125
2018	0.6	219	0.05	10.95
2019	0.7	255.5	0.05	12.775
2020	0.8	292	0.05	14.6
2021	1	365	0.05	18.25
2022	1.2	438	0.05	21.9
2023	1.4	511	0.05	25.55
2024	1.6	584	0.05	29.2
2025	1.8	657	0.05	32.85

To quantify the industry effect these emissions yielded, this analysis utilizes ARB's current emissions projections for year 2020 outlined in appendix D. The oil and gas extraction industry is currently projected to have roughly the same amount of emissions as it did in 2012, around 15 Mt when you subtract the fugitive emissions that are not

included in the program. The estimated 14.6 Mt increase is almost a two fold increase in emissions. This increase in emissions goes beyond just oil and gas extraction companies.

The cement industry, one of the heaviest polluting industries, would increase their production of cement from the oil boom. The well sites require cement casing underground and cement pads strong enough to hold all the equipment. New pipelines would also be built, running between wells and to refineries. Lastly, new roads could be built that make trips for heavy duty trucks carrying equipment easier. Cement plants are estimated to emit 9.2 Mt in 2020, but this analysis predicts this number to double as well to roughly 18 Mt.

Refiners' emissions stand to increase as well. One unique factor for refineries compared to the other industries is that they have a capacity restraint, meaning they might not be able to handle all of the impending shale oil boom. In addition, the refiners must be able to handle the dirty crude coming out of California, and meet emissions regulations. There are already large oil companies such as Exxon who are expanding their refineries to accommodate the dirty crude that originates from California and the tar sands of Alberta, Canada. Much more refineries would need to be built or expanded, however, to handle this oil boom. This would be part of the infrastructure additions that allow the exponential increases in production after 2020, but capacity restraints would force some crude oil to be shipped to the gulf refineries, or overseas to places such as India. The EIA data for the number and capacity of petroleum refineries in California shows a capacity of roughly 2 million bpd, with about 340,000 bpd of idle capacity, or 17 percent (EIA, 2013). With no new refineries or expansions to refineries, the current 2020 ARB emission estimate for refiners of 35 Mt would logically increase 17 percent, to

about 41 Mt. This is a relatively smaller increase in emissions compared to other industries, but expansions of current refineries, and possibly newly built refineries altogether would increase the capacity and amount of crude refined in California. These increased emissions would be partially offset by increased efficiencies in the new plants.

Transport fuel consumption, which Bloomberg New Energy Finance suggests is one of the most important uncertainties in the cap-and-trade market for the next decade, would skyrocket. The most acute increase would be in diesel sales by heavy trucks, which is currently estimated at 41.2 Mt in 2020. The supervisor of DOGGR, Tim Kustic, asserts that one of the limiting factors currently in the Monterey “is that all the fracing equipment has had to come out of Bakersfield, so you had 300-400 miles of transportation cost” (Brown, 2012, p. 2). Trucks carrying heavy equipment running on predominantly diesel would purchase more fuel from transport fuel suppliers in these long trips between Bakersfield and the well sites. In addition, trucks would carry unrefined product to refineries, and refined products to industrial sites. This analysis argues that the 41.2 Mt estimate for 2020 diesel sales could double to around 80 Mt. Gasoline demand would increase from the light-duty trucks at all the well-sites, and lower gasoline prices at the pump for the general public.

The shale oil boom would be a boost to the California economy as a whole. GDP, employment, income, and tax revenue would all rise substantially. A study conducted by the USC students and a think-tank, the Communications Institute, examined the effects of a shale boom on California’s economy. The results of the independent study, which was funded by the Western Petroleum Association, are shown below:

Overview of Incremental California Economic Impacts

	Year	Baseline ¹	Increment ²
Per Capita GDP (\$)	2015	62,000	1,600
Economic activity within the state, divided by the state's population	2020	72,000	10,300
	2025	82,000	11,000
	2030	93,000	8,300
Employment (jobs)	2015	24,329,100	512,000
Total number of people employed in the state	2020	28,253,200	2,815,800
	2025	32,177,200	2,652,800
	2030	36,493,700	1,770,900
Personal Income (\$ millions)	2015	1,928,600	40,600
Total of all income earned by all people within the state	2020	2,239,700	223,200
	2025	2,550,700	210,300
	2030	2,892,900	140,400
Tax Collections (\$ millions)	2015	212,900	4,500
Tax revenue by state, local, & county government	2020	247,300	24,600
	2025	281,600	23,200
	2030	319,400	15,500

Source: *Powering California: The Monterey Shale & California's Economic Future*

¹ Baseline values refer to economic activity in the absence of accelerated shale-oil development.

² Incremented values are the additions to the baseline from accelerated shale-oil development.

These economic estimates assume a very favorable scenario for the degree of expansion in the oil boom, but nonetheless illustrate the point that significant economic growth is highly correlated with increased natural resource production. The California economy, like the majority of other state economies, is still trying to recover from a recession. The state, however, is doing far better than others. The Anderson Report from UCLA publishes arguably the most reputable economic forecasts for the state. Its most recent report cited the fact that:

For the 12 months ending in April 2013, only Utah's employment growth rate rose faster. While the increase in California jobs has been widespread, the economy's strength lies in the state's technology and knowledge-laden sectors, which use

technology and information more heavily, accounting for more than half the job growth. (Anderson, 2013, p. 2)

This trend is expected to increase in 2014 and 2015, adding more disposal income to help boost the recovery. An oil boom would hire many low-skilled workers, who are currently not receiving the benefits of California's economic growth. California's economy would pick up steam and cause increases in output from multiple sectors. This would increase emissions from all sectors across the board. One thing to note, however, is that California is trying to shift to create a green economy that has lower emissions, regardless of economic output. This structural change lowers the increase in emissions from an economy wide boost in output, but would not reverse the shift.

In conclusion, no major breakthroughs in oil and gas production have occurred in the Monterey/Santos shale. This could very well change in the near future if the right extraction method is found. It only took one man, George Mitchell, to revolutionize the Barnett Shale with hydraulic fracturing, which ultimately resulted in the current shale boom in the United States. With the California oil and gas industry largely deregulated until mid-2015, and its compliance obligations relatively unproblematic through 2018, someone could very well strike the sweet spot of the Monterey. The cap-and-trade program would be significantly altered, and demand for compliance instruments would outweigh supply for the first time during the final years of this decade.

CONCLUSION

The purpose of this paper was to examine different scenarios that would impact the California cap-and-trade market in a significant way. The study began by providing an introduction to cap-and-trade markets, and an overview of how the California program

works. Then, the analysis explored the history of the market to date, focusing specifically on California Carbon Allowances (CCA) auction, trading, and pricing data, California Carbon Offsets (CCO) and emissions. The consensus forecasts by market participants and analysts for each of these sectors, and the market as a whole, were illustrated as well.

After laying a foundation for the current state of the program, the rest of the analysis presented examples of possible market disruptions. These included three subsections, threats to the market's existence, bearish market scenarios and bullish market scenarios. The first dealt primarily with outstanding legal cases that could prevent the market from functioning as intended, or altogether. The second discussed situations that would further contribute to the current and projected oversupply of the market, such as the expansion of offset supply and notable emissions reductions. Events like ARB tightening the cap or allowance allocation for covered entities, the legislature slashing offset supply by allowing only California based offset projects, future linkage with Northwest economies who would be net buyers in a carbon market, and unexpected emissions increases comprise the bullish scenarios presented in the last section. In turn, the study identified the two paramount events that would exacerbate an increase in emissions, and investigates these two possibilities in detail.

The first event is the shutdown of the Diablo Canyon nuclear power plant, eliminating the largest source of clean energy in California. Possible causes of the plant coming offline include any further operational problems, investigations into the ability of the plant to withstand a high magnitude earthquake, and the expiration of the plant's license in 2024. Compliance obligations for Pacific Gas & Electric, the company that

operates the plant, would increase significantly, adding demand to the allowance market, and raising prices.

A potential oil boom stemming from a production breakthrough in the Monterey/Santos shale is the second major event that could derail market expectations. The Monterey is the largest crude oil reserve in the United States, with five times the estimated reserves of the next biggest tight oil shale play. The oil industry remains predominately unregulated until June, 2015, when new legislation kicks in. This allows the testing of various extraction techniques, and a production breakthrough could be on the horizon. An oil boom would result in a prodigious rise in emissions not only in the oil and gas extraction industry, but across other sectors as well. The supply demand imbalance of the market would reverse by 2020, and cap-and-trade would be severely changed.

Thus, of all the possible market derailing scenarios, an enormous expansion in crude oil extraction stemming from the Monterey Shale would have the most substantial effect on the cap-and-trade market. Demand, prices and trading volumes would increase dramatically, as many covered entities would surpass their emissions cap and allowance allocations. The continued existence of the cap-and-trade program and the California oil industry after 2020 would come into question, with the juxtaposition of the economic benefits of an oil boom and the underlying goal of the program, emissions reductions.

The California cap-and-trade program is the first of its kind in the United States. The success or failure of this groundbreaking emissions trading scheme remains in question. The answer, however, will certainly reap far-reaching consequences for domestic and global climate policy.

APPENDIX A:**Allowance Budget**

	<i>Budget Year</i>	<i>Annual Allowance Budget</i> <i>(Millions of CA GHG Allowances)</i>
First Compliance Period	2013	162.8
	2014	159.7
Second Compliance Period	2015	394.5
	2016	382.4
	2017	370.4
Third Compliance Period	2018	358.3
	2019	346.3
	2020	334.2

APPENDIX B:**Auction 1: November 14, 2012 Qualified Bid Summary Statistics****Current Auction of 2013 Vintage Allowances**

Total 2013 Allowances Available for Sale:	23,126,110
Total IOU Consigned 2013 Allowances:	21,731,990 (\$219,275,779)
Total POU Consigned 2013 Allowances:	1,394,120 (\$14,066,671)
Total State-Owned 2013 Allowances:	0 (\$0)
Total 2013 Allowances Sold at Auction:	23,126,110 (\$233,342,450)
Total Qualified Bids Divided by	
Total 2013 Allowances Available for Sale:	1.06
Auction Reserve Price:	\$10.00
Settlement Price Per Allowance:	\$10.09
Allowances Purchased by Compliance Entities:	97.0%
Bid Price Summary Statistics	
Maximum Price:	\$91.13
Minimum Price:	\$10.00
Mean Price:	\$15.60
Median <u>Bid</u> Price:	\$12.95
<u>Median Allowance Price:</u>	<u>\$11.81</u>
Hirschman-Herfindahl Index:	1133

Advance Auction of 2015 Vintage Allowances

Total 2015 Allowances Available for Sale:	39,450,000
Total 2015 Allowances Sold at Auction:	5,576,000 (\$55,760,000)
Total Qualified Bids Divided by	
Total 2015 Allowances Available for Sale:	0.14
Auction Reserve Price:	\$10.00
Settlement Price Per Allowance:	\$10.00
Allowances Purchased by Compliance Entities:	91.0%
Bid Price Summary Statistics	
Maximum Price:	\$17.25
Minimum Price:	\$10.00
Mean Price:	\$11.07
Median <u>Bid</u> Price:	\$10.59
<u>Median Allowance Price:</u>	<u>\$10.75</u>
Hirschman-Herfindahl Index:	1485

Auction 2: February 2013 Qualified Bid Summary Statistics

Current Auction of 2013 Vintage Allowances

Total 2013 Allowances Available for Sale:	12,924,822
Total IOU Consigned 2013 Allowances:	9,625,460 (\$131,098,765)
Total POU Consigned 2013 Allowances:	628,940 (\$8,566,163)
Total State-Owned 2013 Allowances:	2,670,422 (\$36,371,148)
Total 2013 Allowances Sold at Auction:	12,924,822 (\$176,036,076)
Total Qualified Bids Divided by	
Total 2013 Allowances Available for Sale:	2.47
Auction Reserve Price:	\$10.71
Settlement Price Per Allowance:	\$13.62
Allowances Purchased by Compliance Entities:	88.15%
Bid Price Summary Statistics	
Maximum Price:	\$50.01
Minimum Price:	\$10.71
Mean Price:	\$14.71
Median <u>Bid Price</u> :	\$12.56
<u>Median Allowance Price</u> :	<u>\$12.91</u>
 Hirschman-Herfindahl index:	 728

Advance Auction of 2016 Vintage Allowances

Total 2016 Allowances Available for Sale:	9,560,000
Total 2016 Allowances Sold at Auction:	4,440,000 (\$47,552,400)
Total Qualified Bids Divided by	
Total 2016 Allowances Available for Sale:	0.46
Auction Reserve Price:	\$10.71
Settlement Price Per Allowance:	\$10.71
Allowances Purchased by Compliance Entities:	100%
Bid Price Summary Statistics	
Maximum Price:	\$40.00
Minimum Price:	\$10.71
Mean Price:	\$12.40
Median <u>Bid Price</u> :	\$11.12
<u>Median Allowance Price</u> :	<u>\$11.10</u>
 Hirschman-Herfindahl index:	 3159

Auction 3: May 2013 Qualified Bid Summary Statistics

Current Auction of 2013 Vintage Allowances

Total 2013 Allowances Available for Sale:	14,522,048
Total IOU Consigned 2013 Allowances:	10,839,537 (\$151,753,518)
Total POU Consigned 2013 Allowances:	1,032,880 (\$14,460,320)
Total State-Owned 2013 Allowances:	2,649,631 (\$37,094,834)
Total 2013 Allowances Sold at Auction:	14,522,048 (\$203,308,672)
Total Qualified Bids Divided by	
Total 2013 Allowances Available for Sale:	1.78
Auction Reserve Price:	\$10.71
Settlement Price Per Allowance:	\$14.00
Allowances Purchased by Compliance Entities:	90.22%
Bid Price Summary Statistics	
Maximum Price:	\$50.01
Minimum Price:	\$10.71
Mean Price:	\$16.67
Median <u>Bid</u> Price:	\$13.49
<u>Median Allowance Price:</u>	<u>\$14.25</u>

Hirschman-Herfindahl Index: 609

Advance Auction of 2016 Vintage Allowances

Total 2016 Allowances Available for Sale:	9,560,000
Total 2016 Allowances Sold at Auction:	7,515,000 (\$80,485,650)
Total Qualified Bids Divided by	
Total 2016 Allowances Available for Sale:	0.79
Auction Reserve Price:	\$10.71
Settlement Price Per Allowance:	\$10.71
Allowances Purchased by Compliance Entities:	86.49%
Bid Price Summary Statistics	
Maximum Price:	\$35.00
Minimum Price:	\$10.71
Mean Price:	\$12.19
Median <u>Bid</u> Price:	\$11.19
<u>Median Allowance Price:</u>	<u>\$11.02</u>

Hirschman-Herfindahl Index: 1198

Auction 4: August 16, 2013 Qualified Bid Summary Statistics

Current Auction of 2013 Vintage Allowances

Total 2013 Allowances Available for Sale:	13,865,422
Total IOU Consigned 2013 Allowances:	10,164,173 (\$124,206,194)
Total POU Consigned 2013 Allowances:	1,051,617 (\$12,850,760)
Total State-Owned 2013 Allowances:	2,649,632 (\$32,378,503)
Total 2013 Allowances Sold at Auction:	13,865,422 (\$169,435,457)
Total Qualified Bids Divided by	
Total 2013 Allowances Available for Sale:	1.62
Auction Reserve Price:	\$10.71
Settlement Price Per Allowance:	\$12.22
Allowances Purchased by Compliance Entities:	95.5%
Bid Price Summary Statistics	
Maximum Price:	\$50.01
Minimum Price:	\$10.71
Mean Price:	\$15.35
Median Bid Price:	\$12.62
Median Allowance Price:	\$13.01
Hirschman-Herfindahl Index:	861

Advance Auction of 2016 Vintage Allowances

Total 2016 Allowances Available for Sale:	9,560,000
Total 2016 Allowances Sold at Auction:	9,560,000 (\$106,116,000)
Total Qualified Bids Divided by	
Total 2016 Allowances Available for Sale:	1.69
Auction Reserve Price:	\$10.71
Settlement Price Per Allowance:	\$11.10
Allowances Purchased by Compliance Entities:	96.3%
Bid Price Summary Statistics	
Maximum Price:	\$30.00
Minimum Price:	\$10.71
Mean Price:	\$11.78
Median Bid Price:	\$10.95
Median Allowance Price:	\$11.10
Hirschman-Herfindahl Index:	1605

Auction 5: November 19, 2013 Qualified Bid Summary Statistics

Current Auction of 2013 Vintage Allowances

Total 2013 Allowances Available for Sale:	16,614,526
Total IOU Consigned 2013 Allowances:	13,049,523 (\$149,808,524)
Total POU Consigned 2013 Allowances:	892,229 (\$10,242,789)
Total State-Owned 2013 Allowances:	2,672,774 (\$30,683,446)
Total 2013 Allowances Sold at Auction:	16,614,526 (\$190,734,758)
Total Qualified Bids Divided by	
Total 2013 Allowances Available for Sale:	1.82
Auction Reserve Price:	\$10.71
Settlement Price Per Allowance:	\$11.48
Allowances Purchased by Compliance Entities:	96.2%
Bid Price Summary Statistics	
Maximum Price:	\$61.61
Minimum Price:	\$10.71
Mean Price:	\$13.43
Median Bid Price:	\$11.53
Median Allowance Price:	\$11.55
Herfindahl–Hirschman Index:	683

Advance Auction of 2016 Vintage Allowances

Total 2016 Allowances Available for Sale:	9,560,000
Total 2016 Allowances Sold at Auction:	9,560,000 (\$106,116,000)
Total Qualified Bids Divided by	
Total 2016 Allowances Available for Sale:	1.64
Auction Reserve Price:	\$10.71
Settlement Price Per Allowance:	\$11.10
Allowances Purchased by Compliance Entities:	91.3%
Bid Price Summary Statistics	
Maximum Price:	\$13.50
Minimum Price:	\$10.71
Mean Price:	\$11.24
Median Bid Price:	\$11.16
Median Allowance Price:	\$11.15

APPENDIX C:

Ozone Depleting Substances Projects				
Date of ARB Issuance	Type of Protocol	Vintage Year	ARB Offsets Credits Issued	Offset Project Operator
9/23/2013	Compliance	2012	306,517	Environmental Credit Corp.
9/23/2012	Early Action	2012	80,612	Diversified Pure Chem, LLC
9/23/2012	Early Action	2012	54,497	Raprec Refrigerants, Inc.
9/23/2013	Early Action	2012	52,500	Perfect Score Technologies LLC
9/23/2013	Early Action	2012	117,496	Raprec Refrigerants, Inc.
10/22/2013	Compliance	2013	107,542	EOS Climate Inc.
10/22/2013	Compliance	2013	50,600	Wabashco, LLC
11/12/2013	Early Action	2011	93,638	Environmental Credit Corp.
		2011	114,836	Environmental Credit Corp.
		2012	142,199	Environmental Credit Corp.
11/12/2013	Early Action	2010	49,000	EOS Climate Inc.
11/12/2013	Early Action	2011	37,359	EOS Climate Inc.
11/12/2013	Early Action	2012	88,955	EOS Climate Inc.
		2012	26,314	EOS Climate Inc.
		2012	61,032	EOS Climate Inc.
		2012	129,503	EOS Climate Inc.
		2012	50,755	EOS Climate Inc.
		2012	100,836	EOS Climate Inc.
		2012	27,070	EOS Climate Inc.
		2012	98,685	EOS Climate Inc.
Total:			1,789,946	
Livestock Digester Projects				
11/12/2013	Early Action	2011	14,887	Camco International Group, Inc.
11/12/2013	Early Action	2012	16,461	TerraPass Inc.
Total:			31,348	

American Carbon Registry Listed Projects				
Project Developer	Project Name	Verifier	Project Type	ARB Status
W. M. Beaty & Associates, Inc.	Devil Fire Reforestation	SCS Global Services	Forest Carbon	Early Action
W. M. Beaty & Associates, Inc.	Storrie Fire Reforestation	SCS Global Services	Forest Carbon	Early Action
Camco International Group, Inc.	Big Sky Dairy	First Environment of California, Inc.	Livestock Waste Management	Listed-Proposed Project
Environmental Credit Corp.	ECC ODS Destruction 2013	SCS Engineers	Ozone Depleting Substances	Listed-Proposed Project
EOS Climate Inc.	EOS ARB ODS 2013-6	NSF International Strategic Registrations	Ozone Depleting Substances	Listed-Proposed Project
EOS Climate Inc.	EOS ARB ODS 2013-6		Ozone Depleting Substances	Listed-Proposed Project
EOS Climate Inc.	EOS ARB ODS 2014-1		Ozone Depleting Substances	Listed-Proposed Project
Brookgreen Gardens	Green Assets-Brookgreen Gar	Environmental Services	Forest Carbon	Listed-Proposed Project
Forest Carbon Partners, L.P.	Hanes Ranch Forest Carbon Pr	SCS Global Services	Forest Carbon	Listed-Proposed Project
Steve Miller and Florence Miller	Miller Forest	SCS Global Services	Forest Carbon	Listed-Proposed Project
Forest Carbon Partners, L.P.	Round Valley Indian Tribes Improved Forest Management Project		Forest Carbon	Listed-Proposed Project
RapRec Refrigerants, Inc.	RR ACR 2013		Ozone Depleting Substances	Listed-Proposed Project

Forestry Offset Projects					
Date of ARB Issuance	Type of Protocol	Vintage Year	ARB Offsets Credits Issued	Forest Buffer Account	Offset Project Operator
11/12/2013	Early Action	2005	108,940	22,809	Willits Woods
		2006	117,275	24,554	
		2007	126,078	26,397	
		2008	135,375	28,343	
		2009	145,194	30,399	
		2010	155,565	32,570	
		2011	166,517	34,863	
		2012	163,731	34,280	
11/12/2013	Early Action	2011	242,131	46,577	Downeast Lakes Land Trust
Total:			1,360,806	280,792	

2008 to 2012 Facility and Entity EmissionsCO₂e, metric tons/year (carbon dioxide equivalents, metric tons/year)

Source Category*	2008	2009	2010	2011	2012
California Facilities					
Cement Plants	8,745,004	5,930,929	5,625,902	6,221,403	7,054,289
In-State Electricity Generation**	46,270,742	43,449,800	39,765,162	30,732,215	41,610,182
Cogeneration	18,058,423	17,338,491	16,374,326	14,471,752	14,398,100
Other Combustion Sources***	10,522,295	9,226,370	9,077,145	9,818,507	11,230,113
Refinery and Hydrogen Plants	36,724,823	34,393,790	34,754,066	34,212,970	33,755,850
Oil and Gas Production	11,349,054	11,237,758	10,972,797	14,591,066	15,181,254
Total Facilities	131,670,341	121,577,137	116,569,398	110,047,913	123,229,788
Electricity Imports and Fuel Suppliers					
Electricity Imports	N A	N A	N A	46,684,882	44,397,471
Transportation Fuel and CO ₂ Suppliers	N A	N A	N A	171,404,802	164,568,890
Natural Gas, NGL, and LPG suppliers****	N A	N A	N A	101,149,851	105,646,007
Total Electricity Imports and Fuel Suppliers	N A	N A	N A	319,239,535	314,612,368
Grand Totals	131,670,341	121,577,137	116,569,398	429,287,448	437,842,156

APPENDIX D:

Forecast last updated: 28 October 2010)

Forecast by Scoping Plan Categories	2020 Emissions
<i>Million tonnes of CO2 equivalent</i>	
Transportation	183.9
<i>On Road</i>	<i>168.1</i>
- Passenger Vehicles	127.0
- Heavy Duty Trucks	41.2
<i>Ships & Commercial Boats</i>	<i>6.0</i>
<i>Aviation (Intrastate)</i>	<i>3.3</i>
<i>Rail</i>	<i>3.6</i>
<i>Unspecified</i>	<i>2.9</i>
Electric Power	110.4
<i>In-State Generation</i>	<i>56.8</i>
- Natural Gas	48.9
- Other Fuels	7.9
<i>Imported Electricity</i>	<i>53.5</i>
- Unspecified Imports	26.8
- Specified Imports	26.8
Commercial and Residential	45.3
<i>Residential Fuel Use</i>	<i>31.0</i>
- Natural Gas	28.9
- Other Fuels	2.1
<i>Commercial Fuel Use</i>	<i>13.9</i>
- Natural Gas	12.5
- Other Fuels	1.5
<i>Commercial Cogeneration Heat Output</i>	<i>0.4</i>
Industrial	91.5
<i>Refineries</i>	<i>35.0</i>
<i>General Fuel Use</i>	<i>14.8</i>
- Natural Gas	9.5
- Other Fuels	5.3
<i>Oil & Gas Extraction</i>	<i>15.8</i>
- Fuel Use	15.0
- Fugitive Emissions	0.7

<i>Cement Plants</i>	9.2
- Clinker Production	5.6
- Fuel Use	3.6
<i>Cogeneration Heat Output</i>	9.7
<i>Other Process Emissions</i>	7.0
Recycling and Waste	8.5
<i>Landfills¹</i>	8.5
High GWP	37.9
<i>Ozone Depleting Substance Substitutes</i>	36.1
<i>Electricity Grid SF6 Losses²</i>	1.0
<i>Semiconductor Manufacturing¹</i>	0.8
Agriculture	29.1
<i>Livestock</i>	16.4
- Enteric Fermentation (Digestive Process)	8.7
- Manure Management	7.7
<i>Crop Growing & Harvesting</i>	8.5
- Fertilizers	7.1
- Soil Preparation and Disturbances	1.4
- Crop Residue Burning	0.1
<i>General Fuel Use</i>	4.2
- Diesel	3.1
- Natural Gas	0.8
- Gasoline	0.4
- Other Fuels	0.0
Forestry	0.2
<i>Wildfire (CH4 & N2O Emissions)</i>	0.2
TOTAL GROSS EMISSIONS	506.8
<i>Forestry Net Emissions</i>	0.0
TOTAL NET EMISSIONS	506.8
¹ These categories are under the Industrial Sector in ARB's GHG Emission Inventory	
² This category is under the Electric Power Sector in ARB's GHG Emission Inventory	

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ABSTRACT

This study focuses on the evolution of the nascent California cap-and-trade market. In particular, the analysis presents different scenarios with the potential to derail the market from its current and projected state. The paper outlines situations that exacerbate the oversupply and bearish outlook for prices, but focuses in particular on the events that could move the market in the opposite direction. Specifically, the analysis explores two sources of market disruption in detail, the shutdown of the Diablo Canyon nuclear power plant and a boom in oil production from the Monterey/Santos shale. Upon completing this evaluation, the study determines that a substantial increase in oil production yields the most profound changes to the market.